CHAPTER 2

STORAGE AND MATERIAL HANDLING

The supply system constantly performs material receipts, storage, and expenditures. These functions are essential elements of providing supply support to aviation maintenance and other organizations. Aviation Storekeepers should know the basic elements that make these tasks easier to accomplish.

Afloat, the supervisor is responsible for ensuring that materials are safely brought on board. The supervisor is also responsible for making sure incoming material is processed properly. Material must be properly identified, inspected or verified (as needed), sorted, distributed, and documented.

Ashore, you may not be involved with the actual receiving and storing of material during normal operating hours. The civilian personnel workforce usually perform these functions; however, you must know the functions to make transactions during emergencies. After normal operating hours, the duty section may be involved in peforming these functions. As the supervisor, you are responsible for making sure the job is properly done. Other tasks the supervisor may get involved with is planning the storage and office layout. The plan may be required for constructing new or additional buildings or rearranging stock to accommodate new procedures.

The efficiency of supply operations depends largely on the smooth flow of material and paperwork. As the supervisor, you should be able to identify storage and support areas that need improvements.

DEFINITIONS OF TERMS

Several terms are used relating to storage and material handling in the Navy. These terms include the following:

AISLE— Any passageway within a storage area.

ALLOCATED SPACE— A definite number of net square feet of a specified type of storage space formal] y apportioned for use.

BAY— Designated area within a section of a warehouse, normally outlined or bounded by posts, pillars, columns, or painted lines.

BIN AREA— An area for the storage of small items.

BINNABLE ORDER PICKING— Order picking system in which small quantities of material are picked from open cases or shelf boxes.

BIN STORAGE SPACE— Area in which bins have been erected, including aisles and working space between bins.

BLOCK STORAGE— Storage of similar containers or material in blocks of two or more units wide, two or more deep, and two or more high.

BRIDGE PLATE— Plate usually made of metal, used to span the space between the truck and the loading platform.

BULK STORAGE— Storage in warehouses of any large quantity of supplies usually in original containers, or storage of liquids, lumber, or petroleum products.

CAROUSEL STORAGE SYSTEM— Endless loop monorail-supported storage system, which moves storage carriers past an operator station.

CUBE— The product of length x width x depth.

DRIVE-INRACK— Pallet rack system in which the pallets are supported on the sides permitting a forklift truck to drive into the rack structure to store or retrieve loads.

FLOOR LOAD— Weight that can be supported safely by a floor, expressed in pounds per square foot of floor space.

FLOOR PLAN— A scale drawing of the floor area of a building showing columns, stairwells, elevator shafts, offices, heads/washrooms, doors, and other structural features.

GROSS STORAGESPACE— Gross area, regardless of its location or designated purpose, used for any operation concerning storage or the support of storage functions.

HAZARDOUS COMMODITIES— Materials consisting of explosives, flammable material, corrosives, combustibles, oxidizers, poisons, toxics, sources of ionizing radiation or radiant energy, biological and radiological, magnetics, and compressed gases that, because of their nature, are

dangerous to store or handle and present real or potential hazards to life and/or property.

HONEYCOMBING— The storing or withdrawing of supplies in a manner that results in vacant space that is not usable for storage of other items.

LAYOUT— A floor plan showing assignment of gross space for storage operations and support functions.

MANNED STORAG/RETRIEVAL MACHINE— A variation of the storage/retrieval (S/R) machine containing an operator cab that permits use of the machine for order picking.

NET STORAGE SPACE— Floor area on which storage racks and/or bins are erected and on which bulk material is or can be stored.

ORDER PICKING TRUCK— A forklift-type of machine on which the driver rides up and down on the mast in an open cab. The vehicle is specifically designed for order picking and is not suitable for pallet Storage/retrieval.

PALLET RACKS— Metal racks of multiple levels used for the vertical storage of pallets.

PLANOGRAPH— A *scale* drawing of a storage area showing the approved layout.

RACK ORDER PICKING— Order picking system in which unopened (full) cases of material are picked from pallets or pallet rack shelving to fill orders.

RACK SPACE-Any floor area identified as a specific location and distinguished from bulk storage, occupied by racks, box pallets, or pallets with metal superstructures installed when used as permanent storage aids.

STORAGE/RETRIEVAL (S/R) MACHINE— A specialized machine, usually computer controlled, used for rapid storage and retrieval of materials.

STRUCTURAL LOSS-In covered warehouses, this is the gross space that is not usable for storage because of obstructions. These obstructions include the frosts, pillars, ramps, door clearances, fire walls, and installed equipment. Structural loss does not include the spaces used for aisles.

In open storage, structural losses are spaces taken up by firebreaks and clearances. Firebreak is a barrier of cleared or plowed land intended to check a grass fire.

SUPPORT SPACE— The storage space used for receiving, shipping, packaging/preservation, inspection/identification, packing, crating, assembly, and offices. It also includes parking areas for material handling equipment (MHE), battery charging stations, rest rooms, tool rooms, locker rooms, time clock area, and break rooms.

SWING ARM SORTER— A sorting device that uses a pivoting arm to sweep an item off a conveyor and onto the proper discharge lane.

TILT SLAT SORTER— A flat surface sorting conveyor built of pivoting slats. A number of slats determined by package size are tilted to discharge the item into the proper lane.

TOTE BOX— A small durable container usually used for order picking and/or shipping of small items.

TOWLINE— A continuous chain conveyor used to pull wheeled carts around a fixed path. The conveyor may be mounted overhead or in the floor.

STORAGE ASHORE

The basic resource of any storage operation is the storage space. The cost of storage operations depends upon the optimum use of the space and efficient procedures for the receipt, storage, and issue of materials. Minimizing cost in storage space can be obtained by thorough planning for the use of the space. The different types of storage facilities ashore are described in detail in the AK3 training manual. The *Warehouse Modernization and Layout Planning Guide,* NAVSUP P-529, provides information in planning the layout of modem storage facilities.

PLANNING THE STORAGE LAYOUT

A storage area floor plan layout is an excellent management tool in the effective use of space. The floor plan shows the divisions of space into storage, support areas, and aisles. The floor plan also shows the square footage of gross space, nonstorage space, and the net space available for storage.

The required storage space is the key factor in planning warehouses ashore. Several factors are used in computing the required storage space. These factors include the following:

- QUANTITY OF INVENTORY. This is the basic part or conversion factor in estimating the required storage space.
- CHARACTERISTICS OF STORAGE FACILITY. This includes storage limitations

such as stacking height, floor capacity, structural clearance, and other obstacles.

- EQUIPMENT CAPABILITIES. Use of potential warehouse storage height may be restricted by the equipment's inability to reach the full vertical space.
- MATERIAL CHARACTERISTICS. The maximum stacking height depends upon the material or its packaging. The material characteristics could cause the stacking height to vary.
- TOTAL WAREHOUSE STORAGE SPACE. The gross storage space within a warehouse includes the support spaces, aisles, structural loss, and net storage space.
- OCCUPANCY OF NET STORAGE SPACE. Occupying the maximum net storage spare can be hindered by ceiling heights, material characteristics, and "elbow room." Sufficient "elbow room" should be available to minimize relocation to make space for new receipts. Fifteen percent of net available space is considered an adequate allowance for "elbow room" for general supplies.
- AISLES. The layout plan must include the aisles to prevent placement-of material in inaccessible areas and loss of space.

MATERIAL FACTORS

Items with similar handling requirements should be stored together when practicable. This will facilitate storing, caring, and moving of material. The fastest moving items should be stored in areas easily accessible to MHE and issue personnel. Loose and unpacked items issue areas should be adjacent to packing and processing areas. Slow moving items should be stored farther from active or processing areas.

DIMENSIONS

The critical factors in developing the layout for storage operations include the relationship between the equipment and warehouse dimensions. Although there are various types and styles of forklift trucks, shelvings, bins, and racks, few conform to predetermined standards. Different makes and styles of forklift trucks require different aisle widths and turning radii. Racks and shelves have different internal dimensions such as column and rail thickness.

OPERATION

Several factors should be considered in planning the layout to support efficient operations. These include handling classification, special handling requirements, pallet rack operations, and small items.

Handling Classifications

There are three basic handling classes of storage in the Navy system. They include the following:

- High cubes and large lots. A limited storage space is needed for bulk or high cube items or large quantity of palletized items.
- Palletized packaged material. These are items of various sires, shapes, and configurations that are stored on pallets. These items include instruments, system components, parts, power tools, and so forth.
- Shelf or bin material. These are small items that can be stored in bins or shelves.

Separation of Elements

Storage spaces used for stowing materials that require special handling need careful planning of storage layout. These are materials that require environmental control, air conditioning, or security and are stored separately from general commodities. Hazardous items should be stored or handled to prevent hazard to personnel and facility. Strict segregation of incompatible materials is mandatory. Incompatible hazardous items, when accidently mixed, could cause fires, explosions, or give off toxic gases. Sensitive items require a high degree of protection and control. Shelf-life items are handled on a first-in, first-out basis.

Pallet Rack Operations

This is the simplest way of handling material. There is no difference in handling a pallet load of batteries or a pallet load of electronic circuit cards. The MHE interfaces with the pallet, and the material on the pallet does not influence the way the material is handled.

Small Items

Small items are materials that can be stored in bins or shelves. In planning the layout, consideration should be given to the shelvings, bins, and MHE. Always consider the number and height of the required

shelvings or carousels and MHE such as high rise stock pickers.

MANPOWER

Planning the layout should include a projection of work schedule and manpower requirements of the supply operation. The layout must accommodate the use of MHE and time of manual operations. For example, if two MHEs are needed to accomplish one day's production in a storage area, the transportation aisles should be wide enough to accommodate them. On the other hand, operating in multiple shifts will require reduced equipment requirements and smaller aisle dimensions. Only one MHE, for the use of first and second shift, will be required to accomplish one day's production.

MATERIAL FLOW

Plan the storage layout to ensure an orderly flow of material. The most critical flow area is located where various operations meet and interact. These areas must have balanced throughput and accumulation space to operate efficiently. The flow pattern that you can use is either the cyclic or the straight line flow. The type of flow pattern selected depends upon several factors. These factors include the function of the facility, relationship between receiving and shipping operations, and the relative size, weight, and quantity of material receipts and shipments.

The cyclic flow pattern is useful for low or moderate storage activities. It permits an efficient use of internal material transport system in moving materials. It allows the transport of material from the receiving area to storage, to order picking, and to shipping docks. Figure 2-1 illustrates a typical cyclic-flow pattern.

The straight line flow is used in high activity operations where the material does not go to intermediate storage. The typical application of this pattern is in a high activity freight distribution area. In this case, the activity receives loads of commodities, sorts them by destination, and reloads them to outbound trucks. This flow pattern emphasizes rapid and direct transfer of material from receiving to shipping. Figure 2-2 illustrates a sample straight-line flow pattern.

SPACE UTILIZATION

In planning the storage facility, the space-utilization layout includes the site space of the building, floor area, and the building "clear height." Planning the site of the building is a job for engineers and architects. You may be involved with planning the warehouse floor area and "clear height" for maximum storage utilization. The following text describes some factors that you should know before you do the plan.

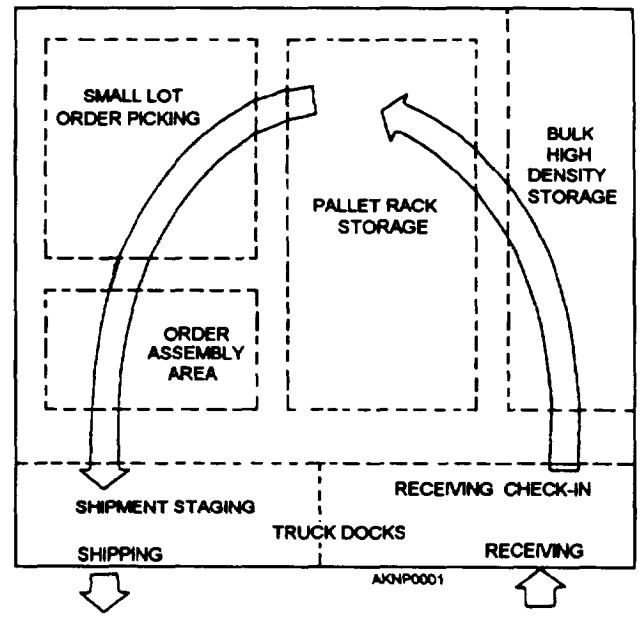

Figure 2-1.-Typical cyclic-flow pattern.

Utilization of Floor Area

The storage pattern for facilities used for pallet rack operations is designed according to the MHE that will be used to move the material. The dimensions of the aisles depend upon the size of the forklift trucks. Material handling and storage methods used to actually

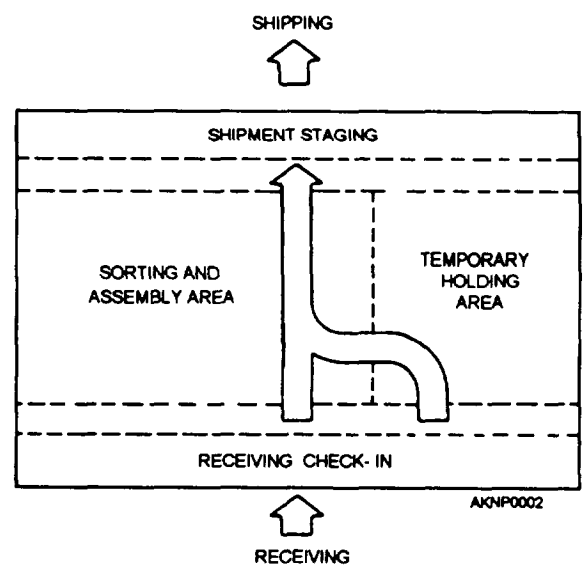

Figure 2-2.—Typical straight-tine flow pattern.

move and store material are affected by some limiting factors. These factors are

- the dimension of the pallet or load to be handled,
- the dimensions of the MHE to move the pallets, and
- the spacing between support columns and overhead clearances.

In general, utilization of floor area is maximized by minimizing aisle spare. Aisle space can be minimized by using modem narrow aisle storage equipment and storing material in depth when possible. An example of depth-type storage are those materials that are inventoried in multiple pallet quantities. See figure 2-3 for an example of storing material in depth. In this example, the different categories of palletized material in each row are identified by letters.

Utilization of Building Clear Height

The term *clear height* is often confusing when dealing with architects or engineneers. It can mean the height from the floor to the bottom of the roof or to the bottom of the beams. In material handling, "clear height" means the height under all lighting, heating, and other overhead obstructions. Clear height is the available effective height for storage space that is below all necessary clearances. The overhead clearance required below the sprinkler system is at least 18 inches for stacks up to 15 feet. This clearance must be at least 36 inches for stacks higher than 15 feet. All overhead obstructions must be 10 inches above the highest equipment clearance level.

The utilization of clear height is affected by the stackability of the material, storage space, MHE, and floor-load limit. When pallet racks are used to achieve storage height, the stackability of material is not critical. When using floor stacked bulk storage, the stackability and instability of material directly affect the height of storage. Using storage aids such as pallet frames will permit load stacking and provide protection to the material.

Aisles

The preplanning of the aisles in the layout must be done before placing material in storage. Aisle layout is determined by the structure of the building, quantity, nature, and activity of the material to be stored. The aisle should be wide enough for maneuvering the type of MHE to be used. The aisle in bins and shelving areas should be wide enough for stock selector trucks. Normally, this requires an aisle of 30 to 36 inches in width. The aisles should provide a straight, clear, and unobstructed passageway. To determine the width of the aisles, use the measurement of the turning radius of the MHE.

The working aisles are used whenever material is placed into or removed from storage. The two types of working aisles are the transportation aisles and the cross aisles. The transportation aisles run the length of the building. The cross aisles run the width of the building. Depending on the activity or operations, most warehouses require two transportation aisles. The aisles should be wide enough to permit two-way traffic for the MHE being used in the area.

Personnel aisles are those used as pedestrians routes only to provide access to doors or other areas. Having this type of aisle should be held to a minimum. Use the working aisles also as pedestrian routes if traffic and safety permits.

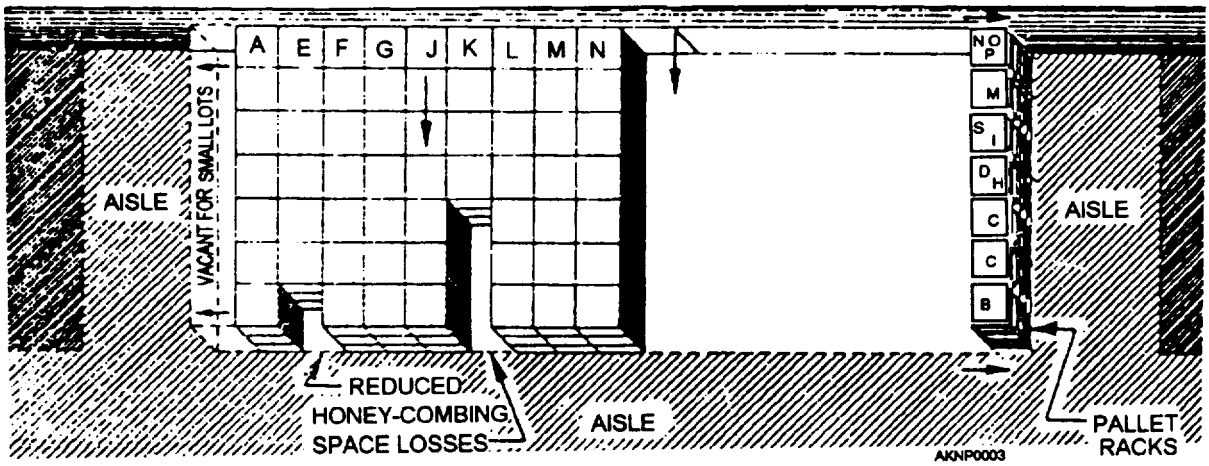

Figure 2-3.-Storing palletized material in depth.

Service aisles are those that permit access to stacks for inventory, inspection, or protective processing. These type of aisle requirements are normally very limited. It is not needed for warehouses that store bulk items in rows with the same number of containers in each pallet. Similar items stored in rows facilitate inventory as well as issue and make service aisles unnecessary.

STORAGE TECHNIQUES

Proper storage techniques used to store, identify, and retrieve materials will facilitate the efficiency of the operation. These storage techniques are the popularity and similarity methods.

The popularity storage technique involves the activity pattern of the material. This is used by storing the items with high activity level (fast movers) closest to the storage and retrieval functions. The purpose for using this technique is to minimize travel time by locating the items as close as possible to the processing locations. 'Ibis method of storage is considered the best since it allows quick access to high demand items. See figure 2-4 for an illustration of the popularity storage method.

The similarity storage technique uses the physical characteristics of the material to classify the items. The two most common methods used in classifying the items are by the type of packaging and stackability of material. The basic principle of similarity storage is that like items should be stored together. 'his technique is commonly used for storing rubber tires, bales of rags, electronic equipment, paints, and soon.

SUPPORT AREAS

The support areas are the nonstorage parts of the warehouse that are used to support various operations. These areas include office spaces, shipping and receiving, battery charging spaces, preservation, packing, and crating.

Office Spaces

The office areas include spaces for the supervisor, secretary, foreman, and clerks that are directly associated with warehouse operations. General administrative offices are not classified as warehouse "support areas." The office area should accommodate one or two people and provide one desk and two chairs per individual. Space should also be provided for filing cabinets, tables, or electronic equipment such as computers.

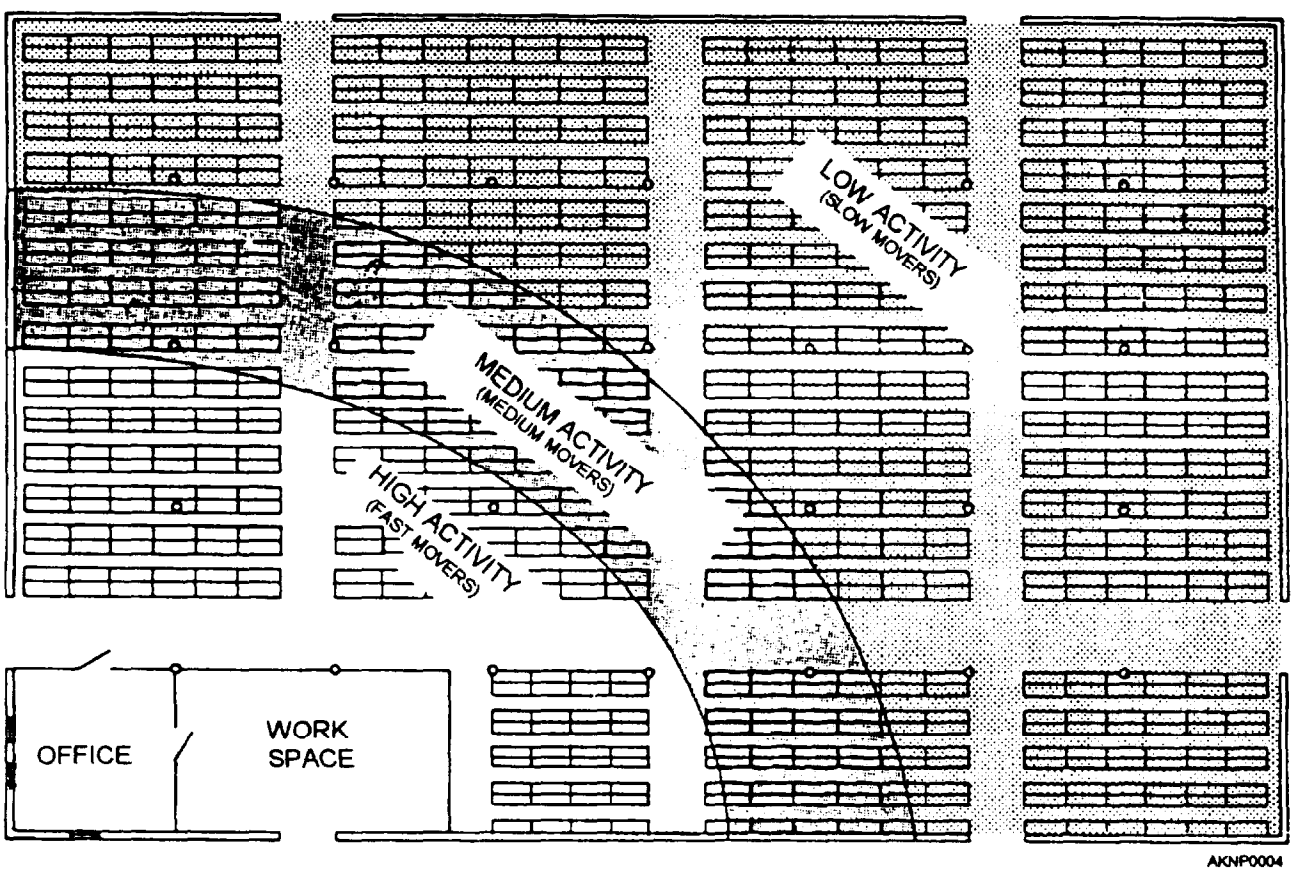

Figure 2-4.—Popularity storage method.

Shipping and Receiving Areas

These areas consist of the staging and load accumulation space used to support the shipping and receiving functions. These support areas may include a small office or desk for use by the shipping and receiving foremen. In general, they do not contain large amounts of Office space.

Truck Dock Areas

Certain areas aree used for loading and unloading highway trailers. They are located immediately in front of the truck dock doors that are used for securing the operating area.

Battery Charging and Handling Areas

These areas consist of the spaces allocated to the charging and handling of vehicle batteries used in the material-handling equipment. When electric vehicles mused, this support area can also include maintenance areas and other work areas associated with the maintenance and upkeep of the material-handling vehicles.

Preservation, Packaging, Packing, and Crating Areas

'These support areas consist of any area dedicated to the protection or packaging of any material being stored or handled in the facility. These areas are generally associated with the receiving function of presentation and the shipping funnction of packing, packaging, and crating areas.

PLANNING THE OFFICE SPACE LAYOUT

The ability to plan an effective and efficient use of office space will be a skill that is useful to you throughout your career. You can refer to *Military Handbook*, *Facility Planning and Design Guide*, MIL-HDBK-1190, for the space criteria to be used.

Planning an efficient layout requires a great deal of thought, study, and a thorough knowledge of the functions for which facilities are to be provided. When a revised plan is not too radically different from the present layout, it maybe possible to make the changes at once. When extensive revisions are indicated, expensive changes may be required and may have to be postponed until a future date. Strive for the best possible solution at the least possible cost. Many times inexpensive substitutions can be made by using familiar items in a new way or by capitalizing on available talents.

Some important items to be considered in preparing layouts are discussed in this section. No effort is made to present a magic plan that can be adapted to fit every situation. To some extent, a good layout depends upon having an efficient organization in the beginning.

The effective use of office space is an important consideration of the supervisor. Like any other part of supply, the office should be designed for production. A poor arrangement of office space wastes time and energy by failing to provide the means for effective work habits. When conditions are such that there is no place to put needed documents or publications, the telephone is on the wrong desk or on the wrong side of the desk, lighting is inadequate, personnel are seated beneath a ceiling vent or facing a window or wall, the flow of work is uneven. Again, when personnel who do detailed or repetitious work are located so that they are constantly interrupted by traffic flow, then the result will obvious] y be less productive.

An office could be defined as a work area for handling information or a production area with data processing equipment. Office planning could then be defined as determining the arrangement of all physical components into a coordinated unit that can most effectively handle the volume of work and the type of information necessary to carry out a mission.

Workflow

The movement of paperwork into and through the office is a fundamental consideration in determining the arrangement of the physical units. Careful planning is required to provide a minimum amount of travel from desk to desk and to prevent the basic circulation patterns from becoming clogged. In an office where large volumes of documents are handled on an individual basis, the flow of work will usually form a constant pattern. The arrangement of components, therefore, can and should be designed to accommodate the flow of paperwork. In contrast, in an office where there is less volume and/or the paperwork is batch processed, the flow of paperwork should not be the dominating factor in determining the office layout.

Objectives

Office layout consists of several objectives that should accomplish the following:

1. Produce a smooth flow of paperwork
2. Use space effectively to assist good supervision
3. Locate equipment, machines, and aisles conveniently
4. Add to the comfort of the people who work there
5. Present a favorable appearance

6. Provide for future expansion, reduction, or moving, as the case may be

Factors for Consideration

While many unique situations may be encountered in planning office layout ashore or afloat, it is not practical to outline a standard procedure to follow here. Some general guidelines are as follows:

- Use one large space in preference to an equal area of small spaces. This permits better lighting, ventilation, supervision, and communication.
- Keep desks, filing cabinets, and other equipment at uniform size in any one area to improve appearance.
- Use straight, parallel lines in the layout. Avoid offsets, jogs, and angular arrangements.
- Provide for paperwork to flow in straight lines, if possible.
- Provide for expanding workloads.
- Keep layout flexible, anticipating future changes.
- Keep related and similar components close together.
- Place supervisors at the rear of their work groups, so they can easily observe problem areas.
- Have working personnel facing in the same direction, not each other.
- Arrange desks so that ample natural light comes over the left shoulder (or right shoulder for left-handed personnel).
- Avoid having personnel face a window or wall, be close to heat sources, or be in line of drafts.
- Provide sufficient electrical outlets for equipment.
- Locate components that normal] y have many visitors near the entrance to avoid disturbing other personnel.
- Locate tiles and frequently used equipment near those who use them.
- Place filing cabinets back to back.
- When possible, provide a lounge area (including vending machines and bulletin boards) so that personnel may relax during rest periods away from their work area without disturbing other working personnel.
- Allocate the prescribed number of square feet per worker as discussed in the following paragraphs.

Spare Standards

When computing the required space for an office, 60 square feet is a desirable standard floor area for each clerical worker. This figure should be doubled for the division officer and the division leading CPO. To illustrate, suppose an office force is to be composed of eight clerical workers plus the division officer and CPO. The space requirement for this office would be 720 square feet (8 x 60) +(2 x 120). An office 20-feet wide and 36-feet long would meet these standards. This standard is based on using double pedestal desks, standard aisles, and the normal accumulation of tiles. There is, of course, no fast rule for the number of square feet per office worker, so this is only for estimation or comparison. The space that can be used is influenced by the nature of the work, the available total area, the number and type of office equipment used, the shape and exposure of the space, and obstructions within the space.

Adequate space may not be available aboard ship to meet these standards. This is overcome partially by using smaller single pedestal desks and by reducing the volume of files. However, the basic considerations are still people, workload, and workflow. The fore, crowded and awkward working areas should not be tolerated if any other solution can be found. Some temporary solutions that might be considered are staggering working hours or establishing a night shift so that some of the desks can be used by two workers, using vacant storage space for office work, taking advantage of school quotas, and borrowing space from other divisions.

Space standards may be broken down in individual items such as desks, chairs, and files. For example, when standard double pedestal desks (60 inches by 34 inches) are arranged as single units with aisles adjacent, or when they are arranged in pairs, end for end, with aisles adjacent to each desk, the minimum space standard from back to back of desks is about 72 inches. This allows a 3-foot space for the chair and for getting in and out from behind the desk. When three or more desks are used end for end, with aisles adjacent to outer desks only, the minimum standard per desk is increased by 1 foot, providing a chair space of approximately 4 feet. The extra foot is required by the middle person for entry and exit.

Figure 2-5 illustrates space standards for various desk arrangements. Generally speaking, the two-desk,

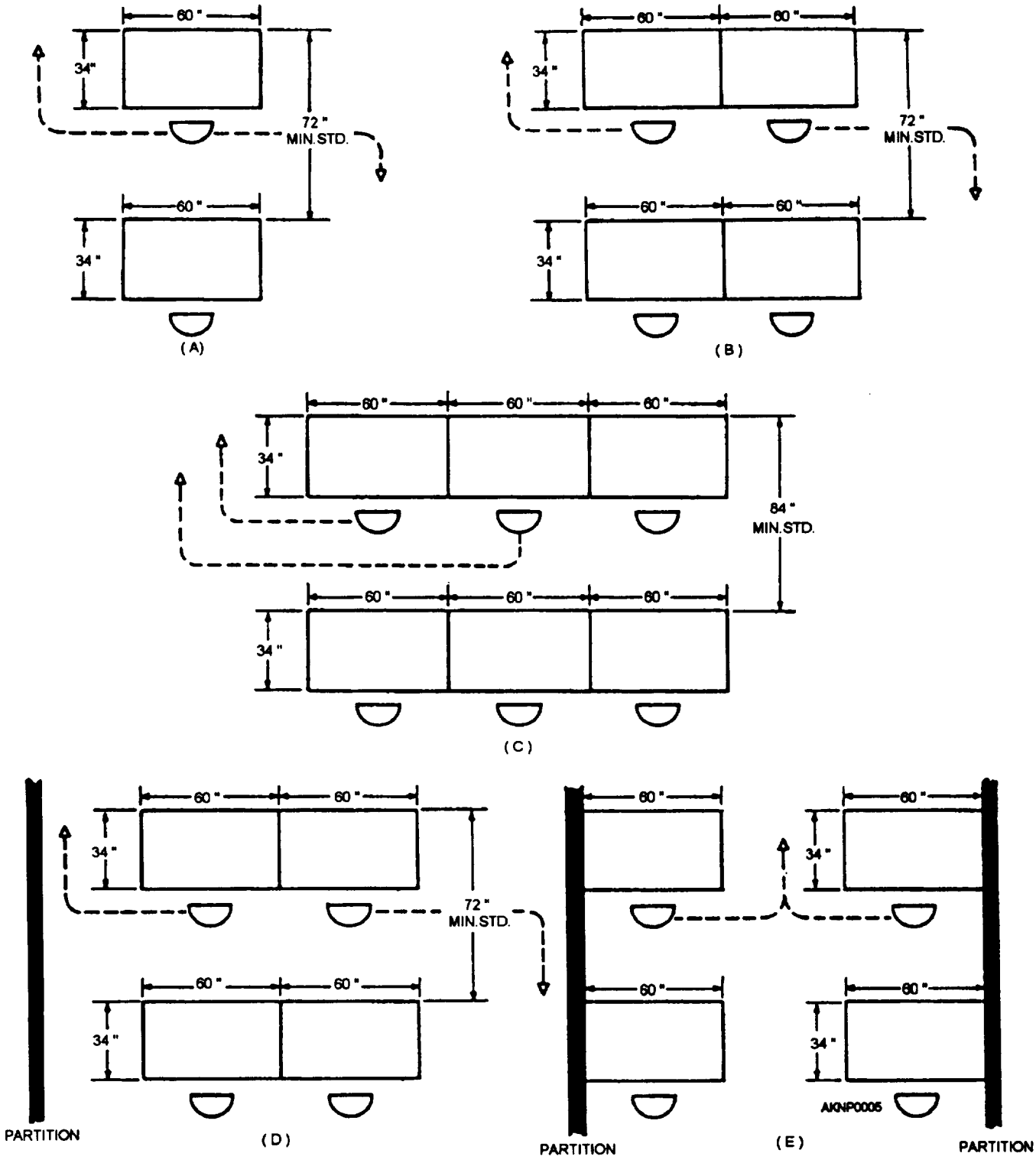

Figure 2-5.-Space standards for desk arrangement A. Single-desk; B. Two desks, end-for-end; C. Three desks, end-for-end D. Two-end aisles; E. One-center aisle.

end-for-end arrangement (plan B, fig. 2-5) requires the least space per worker, and the single-desk arrangement (plan A, fig. 2-5) requires the most. The best arrangement is sometimes influenced by the dimensions of the space as shown in plans D and E in figure 2-5, Aisle space standards should range from 3 feet for secondary aisles to 8 feet for main corridors, depending on the traffic.

The space requirements for filing cabinets depend on the size of the cabinet, the frequent y of use of the material filed, and the arrangement. The standard legal file cabinet is 18- inches wide and 30-inches deep. The drawer opens out an additional 28 inches. For inactive or dead files, no additional aisle space is necessary. For active files, 24 additional inches for the aisle are required, or 36 inches if files are arranged facing each other. Figure 2-6 illustrates some common arrangements of filing cabinets.

BULK STORAGE

The term bulk storage refers to the storage of palletized or packaged item in large quantity of loads per item. You will find this operation in areas dealing with storage of dry goods, paper, or sonobuoys. The operations in these areas usually require the use of material handling equipment (MHE).

In the aviation community, most Aviation Storekeepers work with retail store procedures in the Aviation Support Division/Supply Support Center (ASD/SSC). the AKs use the term *bulk storage* to describe the location of any items that require material handling equipment (MHE) during storage or issue. These items include heavy, bulky, or irregular-shaped material in crates or pallets.

The following text describes the bulk storage procedures for storing items in large quantities.

Factors That Affect Bulk Storage

Some of the factors that you should consider in the layout are described in the following text.

- Item stackability
- Honeycombing
- Inventory profile
- Quantity of storage

You should observe the principle of storage by quantity when developing the stack layout plan. If the stack layout is not planned before storing material, it will result in wasted storage space or inaccessible stock. Storing material by sequence (figure 2-7, view A) can cause honeycombing and storing different material by slot (figure 2-7, view B) may generate locked stock. Figure 2-7, view C, illustrates the maximum use of storage space by applying the space approach, appropriate pallet racks, and a location system.

The objective in floor stacking is to maximize access while minimizing aisle loss. The inventory profile tells the number of items and the number of pallets per item. This will enable you to determine the need for short and deep rows of stock.

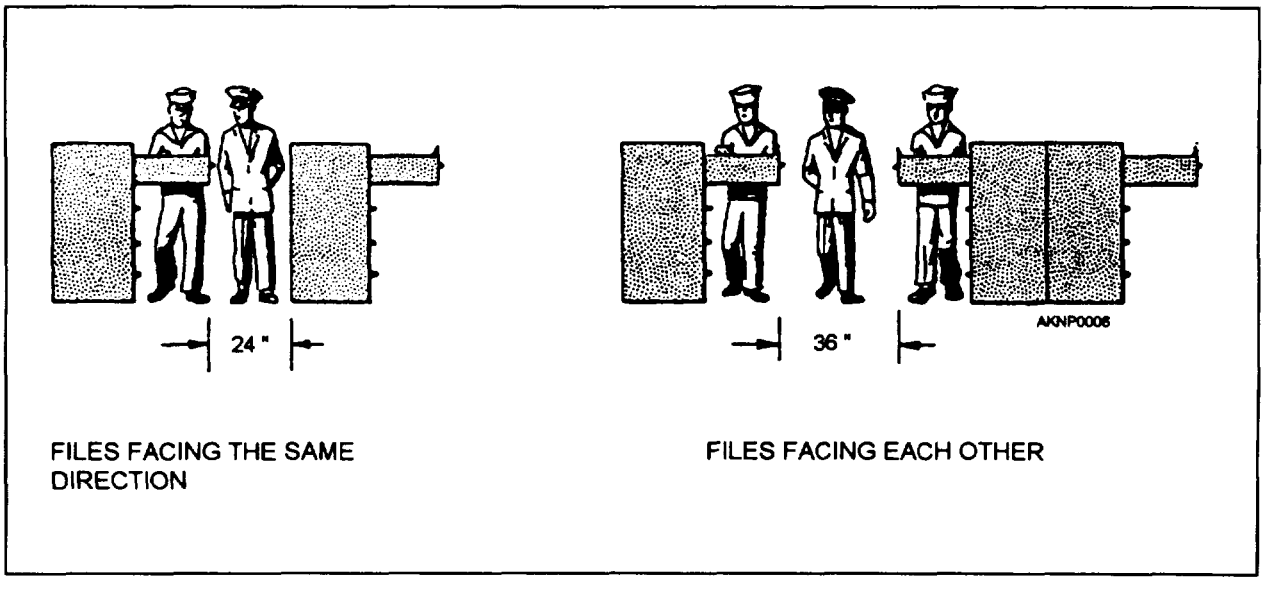

Figure 2-6.-Aisles space for filing cabinets.

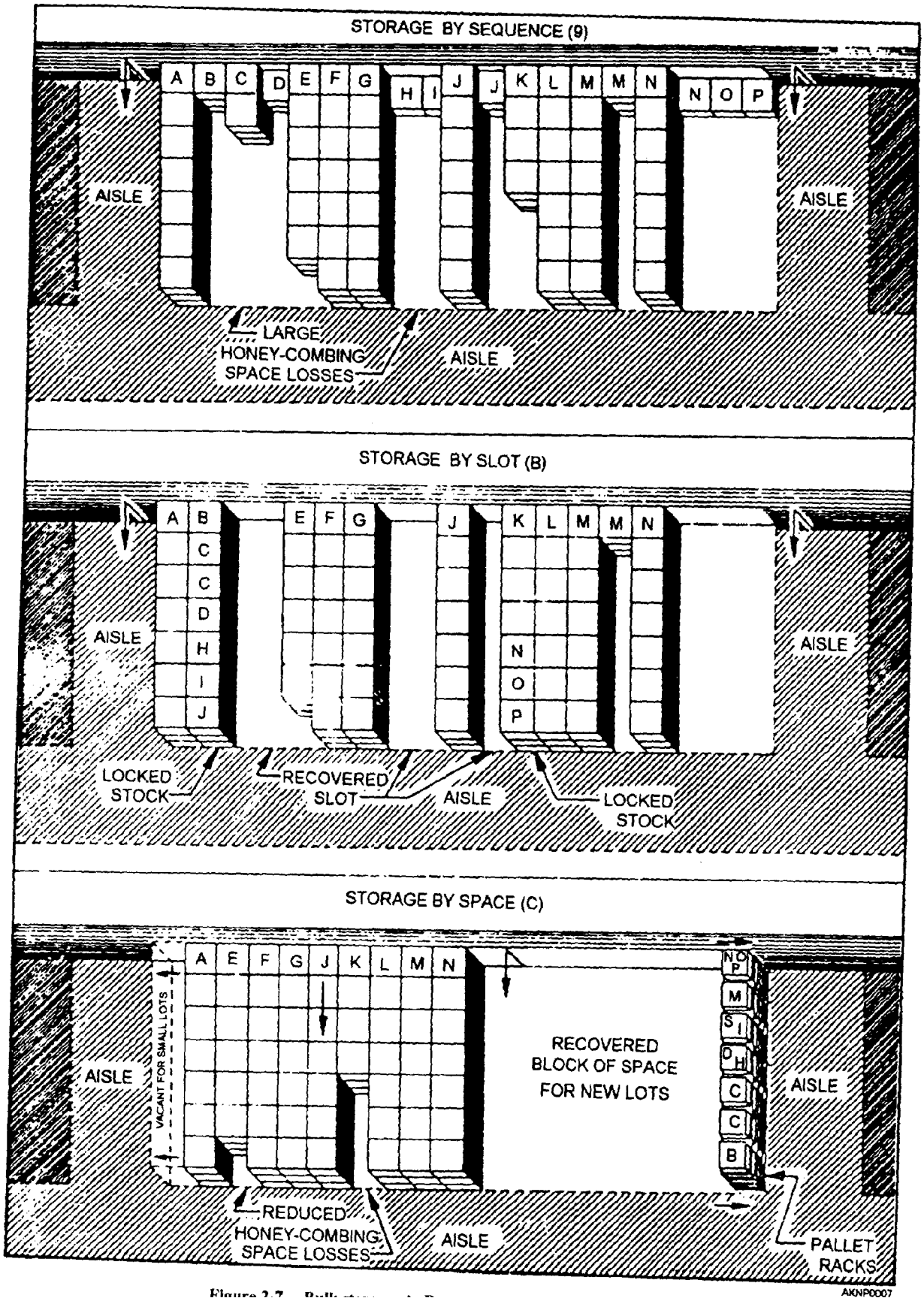

Figure 2-7.—Bulk storage: A. By sequence; B. By slot; C. By space.

Honeycombing is storing or withdrawing of stores that result in a vacant space that is not usable for storing other items. This lost space can be either horizontal (floor area) or vertical above other stock.

Materials in storage that are stacked too high and too deep can pose a problem for the MHE operator. A forklift operator cannot see beyond four stacks of pallets. The operator can be too closely confined when penetrating more than two vehicle lengths in single-width slot (one pallet wide.)

Equipment Considerations

The particular MHE to be used requires different aisle patterns and overhead clearance in building structures.

In planning the storage building, the column spacing is usually coordinated with the MHE. The aisles should be wide enough to accommodate the safe operation of the MHE.

It is also essential that the overhead and obstruction clearance above the maximum lifting height of the the MHE. To fully use the lifting capability of the MHE, the building must have an adequate overhead clearance above the maximum lifting height of the MHE.

SHORE HAZARDOUS MATERIAL STOWAGE

Shore hazardous material storage areas will be designated following the base fire marshall's recommendations, local regulations, and NAVSUP Publication 573. Chapter 4 of NAVSUP Publication 573 discusses the Department of Defense (DOD) requirements for facilities designed to store hazardous material.

STORAGE LAYOUT AFLOAT

The term stowage is most often used for storage afloat. Stowage of material afloat requires that you know how to determine the stowage layout best suited for the material, that you know the precautions to be taken to safeguard both the stores and the ship, and that you be familiar with the rules governing the accessibility of the stores.

SPACE ALLOCATION AND LAYOUT

Stowage space afloat varies from one ship to another. The physical arrangement of material is dependent upon the internal construction of the storeroom to be used. The location of doors, hatches, nonstructural stanchions, ventilation ducts, and other obstructions should be reviewed to permit the maximum use of the space available for stowage. Requirements for enclosed bins, open racks and shelving, stanchions, gratings and battens, and miscellaneous storeroom accessories must be determined to achieve efficient stowage.

in planning the stowage layout and allocation of available storeroom space, you must consider the categories of stores that are to be stowed separately (for example, commissary, ship's store, ship's repair parts, general stores, and aviation stores) and the volume of storage space that is required for each category.

SPACE LAYOUT FACTORS

The detailed stowage layout should be arranged to allow for maximum stowage capacity, access to all stores, orderly arrangement, and security/safety of stores. Essential items should be dispersed in stowage among the various sections of the ship to reduce the effects of battle damage to particular parts of the ship. Material that is bulky, fragile, perishable, flammable, susceptible to damage by heat or moisture, or that possesses any other physical characteristics that affect the safety of the ship or personnel should be given primary consideration in the layout of stowage plans,

Material should be stowed in spaces as near as practical to where the items are to be used. Heavy bulk items should be located so that a minimum of handling is required. Items that must be handled by personnel should be placed to minimize the risk of injury when lifting. Where MHE cannot be used, items should be broken down into units that can be safely lifted by one or two individuals. Storerooms serviced directly by ship's hatches and cranes receive first consideration for purposes of bulk stowage. Special racks may be installed on the hangar deck for stowage of fuel drop tanks, helo blades, and so on. Hangar deck and gun sponson spaces may be allocated for the stowage of aircraft engines, catapult seals, arresting gear cables, buddy stores, and so on. Other factors to consider are as follows:

- Locate light, bulky material in storerooms with a high overhead clearance (to maximim the use of available space).
- Segregate materials that are similar in type or classification (for example, hazardous/ nonhazardous, large/small, shelf-life/nonshelf-life).
- Locate frequently requested material as close as possible to the point of issue and in storerooms that are most convenient to maintenance personnel.
- Locate shelf-life items in a readily accessible area to facilitate periodic screening.
- Install appropriate stowage aids in spaces in which they can be effectively used.
- Provide for aisles that are at least 30-inches wide between bins, racks, and/or cabinets.
- Arrange materials with identification labels facing outward to facilitate issue and inventory.
- Place hazardous materials in designated storage areas, segregated by compatibility and hazard.
- Avoid, as much as possible, multiple locations for the same item.

MATERIAL IDENTIFICATION

Storeroom custodians should make sure that all items in stowage are legibly marked, tagged, or labeled with a stock number, Navy Item Control Number (NICN), or other appropriate identification markings. When necessary, technical assistance from other departments may be requested to determine proper identification of unmarked or illegibly marked materials. Items that cannot be identified must be turned in ashore for disposition.

Hazardous materials that are missing labels or are not properly labeled with the name of the material, hazard of the material, and name and address of the manufacturer, should be refused receipt. Containers of hazardous material obtained through open purchase should be accepted only if they contain a manufacturer's label with the name of the material, hazard of the material, and name and address of the manufacturer. The afloat or base Hazardous Material Coordinator will be contacted if any hazardous materials in storage are discovered to be lacking proper labeling.

MATERIAL PROTECTION LEVELS

Material procured for the Navy is provided the degree of preservation, packaging, and packing specified by the cognizant inventory manager to the extent necessary to protect the material from deterioration and damage during shipment, handling, and stowage. For definitions of specified protection levels and descriptions of codes marked on unit packages and exterior shipping containers, you should refer to *Supply Afloat Packaging Procedures,* NAVSUP P-484. You should also refer to this publication to determine adequate protection of ready for issue (RFI) materials and unserviceable mandatory turn-in repairable to be transferred to another activity.

STOWAGE LOCATION SYSTEM

The general storeroom layout is basically the same on each ship; that is, the storerooms are numbered or lettered in sequence beginning with storeroom forward on the starboard side, and progresses from starboard to port, upper level to lower level, and bow to stem. The locations within a storeroom are generally numbered with the numbering system being uniform in all stowage spaces.

The location of each item in stock will be maintained on tape in the Shipboard Uniform Automated Processing System (SUADPS) master record file (MRF) and printed as part of the master stock status and locator listing (MSSLL). The maximum number of locations for one item listed in the MSSLL is four. Each location will be designated by a five-character alphanumeric number (for example, Al 238), except when the configuration of the storage area or physical characteristics of the material dictate an alternate system. Instructions applicable to records for stock material located in other departmental spaces can be found in chapter 6 of *Afloat Supply Procedures,* NAVSUP P-485.

STOWAGE AIDS

Consistent with the stowage criteria and layout factors, storerooms are outfitted with bins, racks, shelving, lockers, drawer cabinets, deck grating, battens, and or other stowage aids best suited for the types and quantities of material to be stowed. Refer to chapter 4 of NAVSUP P-485 for illustrations of different types of stowage aids used afloat. When stowage aids need to be modified or relocated, or when additional aids must be manufactured by a repair ship

or shipyard, an appropriate work request must be submitted using the *Ships' Maintenance and Material Management (3-M) Manual,* OPNAVINST 4790.4.

HAZARDOUS MATERIAL STORAGE

Certain materials with inherent hazardous properties require special stowage facilities and handling precautions. Afloat hazardous material stowage is more restrictive than shore requirements for damage control purposes. Storage requirements for each type of material are provided in OPNAVINST 5100.19, chapters C23 and D15, on the Material Safety Data Sheet (MSDS), and in NAVSUP Publication 573.

MSDSs are available on the Hazardous Material Information System (HMIS), which replaced the Consolidated Hazardous Item List (CHIL). The HMIS is distributed on compact disk-read only memory (CD-ROM) format only. The HMIS in compact disk (CD) format contains both the DOD 6050.5L and DOD 6050.5LR. The CD format is issued quarterly. Each issue contains updates in its entirety.

The HMIS provides the users the information needed to properly manage hazardous materials. 'The system provides Material Safety Data Sheets (MSDSs) for standard stock numbered items, and a wide range of information concerning safety, health, packaging, and labeling. The HMIS gives a Hazard Characteristic Code (HCC) for each item, which defines the storage requirements. The HMIS also lists the transportation information and disposal code for each item. The disposal code indicates the pretreatment method and ultimate disposal action prescribed for spilled, spoiled, or other waste quantities of the item to which it applies. The HMIS does not contain information for items procured through open purchase.

The Ships Hazardous Material List (SHML) is a record of the hazardous material (HM) carried aboard U.S. Navy ships for which there exists a valid requirement. The SHML provides ships with the capability of determining which hazardous materials are authorized for shipboard use to preclude stocking of materials for which the ship has no use. Materials which do not appear on the SHML should be suspect of being in excess and should not be ordered. A SHML Feedback Report can be submitted to add items to the SHML if a valid requirement exists. Quantities of materials are not provided in the SHML, nor is the SHML to be used as specific to a ship or ship class. The SHML is a list of HM that any ship with a valid need is authorized to have on board. The Material Safety Data Sheet (MSDS) in the HMIS will state in the first section whether or not the item is authorized by the SHML.

NOTE: The SHML in CD format has been incorporated into the Hazardous Material Control and Management Program (HMC&M). The HMC&M in CD format contains the SHML, HMIS, and Hazardous Material User's Guide (I-MUG).

To report SHML inconsistencies or new products, use the feedback report, NAVSUP Form 1400. This form is included in the SHML on the CD and an example is illustrated in chapter 2 of NAVSUP P-485.

If the item to be reported has an assigned national stock number (NSN) and application data, but not listed in SHML, submit the report directly to Naval Inventory Control Point-Mechanicsburg (NAVICP-MECH). This type of report does not require the commanding officer's (CO's) approval. Send an info copy of the report to the applicable type commander (TYCOM).

The report for items that do not have assigned NSNS or application data and not listed in the SHML will require the CO's approval. The report must be signed by the CO and submitted to NAVICP-MECH via the TYCOM.

When procuring nonstandard HM, the request must include a copy of the approved SHML Feedback Report. The approved report will serve as required certification to procure the nonstandard HM that is not listed in the SHML.

SHIPBOARD HAZARDOUS MATERIAL STOWAGE

Shipboard stowage facilities commonly used for hazardous items are discussed in the following paragraphs.

NOTE: FOR THE HAZARD CHARACTERISTIC CODES (HCC'S) OR SMCC'S FOR THE FOLLOWING ITEMS, SEE OPNAVINST 5100.19, APPENDIX B3-E.

FLAMMABLE LIQUIDS STOREROOMS

The flammable liquids storeroom is normally located at either end of the ship, below the full-load waterline, not adjacent to a magazine, and is equipped with an automatic fire alarm and fire extinguishing system. This type of storeroom should also be equipped with incandescent and explosion-proof overhead lights (protected by lamp guards), with the switch located outside the compartment, and nonsparking vent fans

with the controllers located outside the compartment. Flammable items requiring stowage in the flammable liquids storeroom are assigned Hazard Characteristic Codes (HCCs) or special material content codes (SMCCs) in the HMIS as follows

- Liquids: Codes F, J1, G, P (when applicable to wood alcohol)
- Pastes, greases, and other semisolids: Code G
- Solids: Code J2

ACID LOCKER

An acid locker is a leak-proof lead-linedbox, chest, or locker especially designed for stowing bottles or carboys of acid. A label bearing the inscription ACID BOTTLE STOWAGE in 3/8-inch letters must be securely attached to the lid of each acid locker. Acid lockers for flammable acids are kept in the flammable liquids storeroom. However, acid lockers that contain only medical acids may be kept in a medical storeroom under the custody of the medical department representative. Items that must be kept in the acid locker are assigned Special Material Content Code (SMCC) "C" in the HMIS. Nitric acid, which is coded Cl, must be kept in the acid locker.

ALCOHOL LOCKER

An alcohol locker is a chest or locker used for security stowage of grain alcohols that are highly susceptible to pilferage (that is, ethanol or ethyl alcohol). Alcohol lockers are located in the flammable liquids storeroom. However, lockers that contain only medicinal alcohol (100 proof or less) maybe located in any secure space designated by the commanding officer, as described in chapter 1, paragraph 1118-4c of NAVSUP P485.

TYPES OF HAZARDOUS MATERIALS

Some materials have inherent properties that make them hazardous to personnel, to the ship, or to both. These materials can be stowed safely when the proper care and precautions are taken.

Acid

Stow liquid inorganic acids, such as hydrochloric, sulfuric, nitric, an phosphoric, bottled in glass or plastic in such a manner that they are cushioned against shock. They should be kept in their original shipping carton inside suitable acid-resistant lockers, cabinets, or chests, located in storerooms below the full-load waterline.

Except where stowed in chests or lockers, the lower part of the bulkhead where acids are stowed must be covered with a watertight rubber lining. A label inscribed ACID BOTTLE STOWAGE in 3/8-inch letters must be attached securely to the outside of the storeroom door. Acids should be stowed separately from oxidizing or flammable materials. Corrosive acids (or vapors) must not be allowed to come in contact with the skin ore yes. Storeroom custodians who stow or issue these acids should wear rubber gloves, rubber aprons, and goggles to protect themselves and their clothing from acid burns.

Alkalies

Alkaline materials are also classified as corrosives, but have different chemical properties from acids. Alkalies, such as lithium hydroxide, sodium hydroxide, lye, phosphates, laundry products, and oven cleaners must be stowed in designated lockers, cabinets, or chests, separated from acids, oxidizers, and other incompatible materials. Ensure the stowage area is dry.

Alcohol

Since most commonly used alcohols have a flash point below 100°F, all alcohol will be stowed in the flammable liquids storeroom. Not all alcohol is readily identifiable by name. For example, many lacquer thinners have methanol (wood alcohol), which is extremely poisonous, as the principal ingredient. The HMIS identifies these items by name and NSN. As stated before, grain alcohol (ethanol or ethyl alcohol) must be stowed in an alcohol locker.

Oxidizing Material

Many shipboard fires with resultant fatalities have been attributed to improper stowage or handling of oxidizing materials, particularly calcium hypochlorite. Oxidizing materials listed in the HMIS are identified by HCC "D" SMCC "J." Nitric acid, a strong oxidizer, must be stowed in the acid locker. Oxygen, gas, and calcium hypochlorite must be stowed according to the following paragraphs on calcium hypochlorite and compressed gases. All other oxidizers are stowed in a dry compartment, away from combustible materials.

Calcium Hypochlorite

Calcium hypochlorite itself is noncombustible; however, it is a strong oxidizing agent that generates heat, liberates chlorine, and causes fire when stowed in contact with paints, oils, greases, detergents, acids, alkalies, antifreeze, fabrics, and other organic and combustible materials. Calcium hypochlorite must be stowed in bins or lockers labeled HAZARDOUS MATERIAL-CALCIUM HYPOCHLORITE in red letters on a white background. The bins or lockers should be located at least 5 feet away from any heat source or surface that may exceed 140 degrees Fahrenheit. The bins and lockers should not be subject to condensation or water accumulation. The are a must not be adjacent to a magazine and must not be used for storing combustible organic materials. An individual locker or bin must contain no more than 48 six-ounce bottles.

Compressed Gases

Compressed gases must be stowed on the weather deck unless the ship has below-deck stowage spaces specifically designed for such material. Compressed gas cylinders must be stowed vertically and securely with valve protection caps in place, away from other flammable materials, especially grease and oil. When compressed gases are stowed on the weather deck, the cylinders must be located as far as possible from navigation, fire control, or gun stations, and must be protected from the direct rays of the sun or accumulation of snow and ice. When compressed gases are stowed below decks, precautions must be taken to prevent leaking gases from entering ventilation air intakes leading to working or living spaces. Usually, empty cylinders still have some gas remaining in the cylinders; therefore, empty cylinders must be stowed and handled with the same precautions as full cylinders, and labeled "MT." Compressed gases, particularly the flammable and explosive gases, must be handled with extreme care, Some general rules for handling compressed gas cylinders are as follows:

- Take every precaution to prevent cylinders from being dropped or forcefully struck against hard surfaces (including other cylinders). Do not tamper with the safety devices in cylinder discharge values, When cylinders are not in use, make sure that the valve protection caps are securely attached.
- Prevent cylinders from contact with fire, sparks, or electrical circuits.
- Do not drag or slide cylinders. They should be secured and moved by hand trucks, or tilt the cylinders and roll them on the bottom edge.
- Secure cylinders in a cradle, pallet, or rack when they are loaded or off-loaded with a crane or derrick. Never hoist cylinders with electromagnets or with hooks or line attached to the valve protection cap.
- Do not alter or deface the numbers or other markings on cylinders; do not add markings without approval of the engineer officer; and do not issue cylinders if the contents cannot be identified.

Detailed information relative to the stowage, handling, and use of various types of compressed gases is contained in the *Naval Ships' Technical Manual,* chapter 550. For specific markings and color codes that apply to cylinders of compressed gases, refer to *Military Standard, Color Code for Pipelines and Compressed Gas Cylinders,* MIL-STD-101B. The hazardous gases commonly used by ships include acetylene, oxygen, propane, and various refrigerants.

Acetylene is inherently unstable and may explode when subjected to heat or shock, or upon contact with chlorine or certain metals such as copper, silver, and mercury. Therefore, acetylene must be stowed separately from oxygen or any other materials with which it forms an explosive compound; the gas must never be allowed to escape into an enclosed area; and the cylinders must be protected from flames, sparks, lighting, and static electricity. Test for suspected leaks with soapy water.

In moderate concentrations, acetylene may act as an intoxicant. In higher concentrations, it will cause unconsciousness, and ultimately, asphyxiation. Some grades of acetylene also contain many impurities. Therefore, breathing of acetylene in any concentration for any length of time must be avoided.

Acetylene in cylinders is dissolved in acetone, which has a tendency to flow into the valve if the cylinders are stowed horizontally. For this reason, acetylene must be stowed and used only in an upright position, valve end up. When it is known or suspected that acetylene cylinders have been stowed on their sides, they must not be used until they have been in a vertical position for at least 2 hours.

NOTE: CHLORINE GAS IS NOT AUTHORIZED FOR SHIPBOARD USE.

Oxygen and chlorine are oxidizing gases that because they can bum without air, strongly support combustion. Oxygen and chlorine cylinders must be stowed on the weather deck or in a separate watertight storeroom that has at least one compartment between it and any space that is used for the stowage of combustibles such as flammable liquids or gases, ammunition, paint, gasoline, and oil.

Nonflammable gases include helium, nitrogen, carbon dioxide, and argon. Because of their inert characteristics, they may be stowed with flammable or oxidizing gases. However, since these nonflammable gases will not support respiration (a sufficient concentration in a closed space will cause asphyxiation), they must be stowed on the weather deck or in other well-ventilated spaces.

AEROSOLS

Aerosol products are liquids, solutions, or powders suspended in a gas propellant and contained in dispensers equipped with release valves. Containers of aerosol are used for the disposal of paints, enamels, lacquers, insecticides, silicones, rust preventives, and so forth. The aerosol propellants may be low-boiling halogenated hydrocarbons or other hydrocarbons such as liquified propane or isobutane. Aerosol cylinders will burst if exposed to heat sources in excess of 120°F and are prone to leakage if subjected to impact. Aerosol propellants are extremely flammable and, insufficient concentration, can be anesthetic or asphyxiating. All aerosol products, therefore, should be stowed in the flammable liquids storeroom or in cabinets away from oxidizing materials. A mechanical ventilation must be used, when necessary, to remove accumulated vapors in storage spaces.

Flammable or Combustible Material

Flammable liquids have a flash point of 100°F or below. Combustible liquids, greases, and pastes have a flash point of 200°F or below. Items that are flammable and/or combustible include the following:

- Gasoline, oils, kerosene, and other petroleum products
- Chemicals
- Stencil paints, marking inks, and printer's ink
- Solvents, thinners, primers, compounds, varnishes, and lacquers
- Alcohol, acetone, ether, and naphtha
- Greases and pastes

Except for drummed petroleum products that may be stowed in racks on the weather deck, flammable liquids, and other flammable or combustible material must be stowed in the flammable liquids storeroom.

Radioactive Material

Radioactive items are listed and identified by SMCC as R (or X, if radioactive and magnetic) and an HCC of "A." Radioactive instruments, electron tubes, and certain other items are labeled with the conventional United States Nuclear Regulatory Commission (USNRC) radiation symbol, which must not be removed or obliterated. The radiation levels of radioactive material depend upon the type and concentration of isotopes in each unit and the number of units stowed together. Any area used for stowage of radioactive material must be conspicuously posted with the standard radiation symbol and the words CAUTION- RADIOACTIVE MATERIAL and, as a minimum, must be monitored when initial or replenishment stocks of radioactive items are being stowed. Rubber gloves must be worn, and extreme caution must be used in handling damaged or broken radioactive material to avoid being absorbed through skin abrasion.

WARNING

Any suspected radiation hazard must be promptly reported to the radiological safety officer and a representative of the medical department.

Toxic Substances

Poisonous substances can cause discomfort, asphyxiation, or even death if ingested or inhaled, or if absorbed through the skin. Therefore, adequate precautions must be taken to prevent such dangers when stowing or issuing toxic material. Toxic substances, which do not fit any other category of stowage such as flammable liquid or acid, must be stowed in a cool, well-ventilated area, separate from acids, and must be protected from fire hazards or impacts that may break seals or damage the containers. Each case, carton, and individual container of toxic material must contain a warning label with the words POISON! IF TAKEN

AND POSSIBLE DEATH! It is particularly important to make sure that containers of poisonous liquids, such as industrial alcohol, are clearly identified and labeled to prevent human assumption, which can be fatal. The most commonly used toxic substances on board ships are pesticides.

HAZARDOUS MATERIAL SPILLS AND EMERGENCIES

When using MHE or moving quantities of hazardous materials between receiving, storage, and issue, the possibility exists for spills and mishaps. Some hazardous materials can cause severe health hazards, burns to the skin and eyes, or give off toxic gases. Spilled material can endanger the facility, the ship, personnel, and the environment. Material Safety Data Sheets (MSDSs) provide emergency spill procedures, and every base or ship has spill contingency plans and a spill response team in place should a mishap occur. Supply personnel should be trained on emergency procedures should shipping containers fall or break open, if material contacts personnel, or if a fire occurs in a hazardous material area. Supply personnel should also be trained in the use of safety equipment, such as extinguishing systems, ventilation units, personal protective equipment, and alarms.

MEASUREMENT OF STORAGE SPACE

Measurement of a storage space is an important part of planning the space layout for storage or office areas. You will also use the standard measurements of bins, pallet racks, pallets, and other storage items. Shore activities are required to prepare and submit the Storage Unit Report, NAVSUP Form 605. The *Supply Ashore*, NAVSUP Publication 1, Volume 2, describes the procedures for preparing the report. Although every AK may not be involved in the actual preparation of the report, you may be asked to provide some of the information. The following information will help you learn some of the terms and computations used in storage operations.

TOTAL GROSS STORAGE AREA

Measure the total gross area by multiplying the length by the width, in feet, of the inside dimensions of the building. Measure from wall to wall and disregard the inside structures such as fire walls, passageways, ramps, stairwells, and so forth. The result will be the square-foot area or total-gross area. The measurement will be less than the outside dimensions by the thickness' of the walls.

Some storage buildings may have a cutback in the walls or areas not designed for storage. The measurement of the cutback is excluded from the total gross area.

Open storage may be either improved or unimproved. The total gross storage area must include the entire own improved area. For an open unimproved area, report only the area actually occupied by stores or used in support of storage operations.

GROSS SPACE FOR STORAGE OPERATIONS

To calculate the gross space for storage operations, take the gross storage area minus the unusable space, standby spare, and space outgranted to other DOD or non-DOD activities.

NET STORAGE SPACE

To get the NET STORAGE SPACE (in feet), take the total gross space for storage operations minus gross space used for aisles, structural loss, and support spaces. The result will be in square feet.

The aisles include the fire aisles, personnel access aisles, main aisles, and cross aisles.

The structural losses are those areas not usable for storage because of obstructions caused by their characteristics. These include the pillars, posts, ramps, door clearances, and fire walls. These also include the spaces occupied by equipment such as electrical panels, dehumidifiers, and so on. In open storage, structural loss includes fire breaks and clearances for utility lines.

The support space is the gross space used in support of storage operations. These spaces include shipping, receiving, packing and preservation, and offices. Other areas include MHE parking areas, battery charging stations, rest rooms, locker rooms, and the time clock area.

TOTAL CUBIC FEET CAPACITY

For covered storage, the total cubic feet is computed by multiplying the net storage space (SQ FT) by the stacking height. The stacking height is the distance from floor to the unobstructed stacking height that is permitted by safety regulations. See figure 2-8 for an example of determining the cubic space capacity.

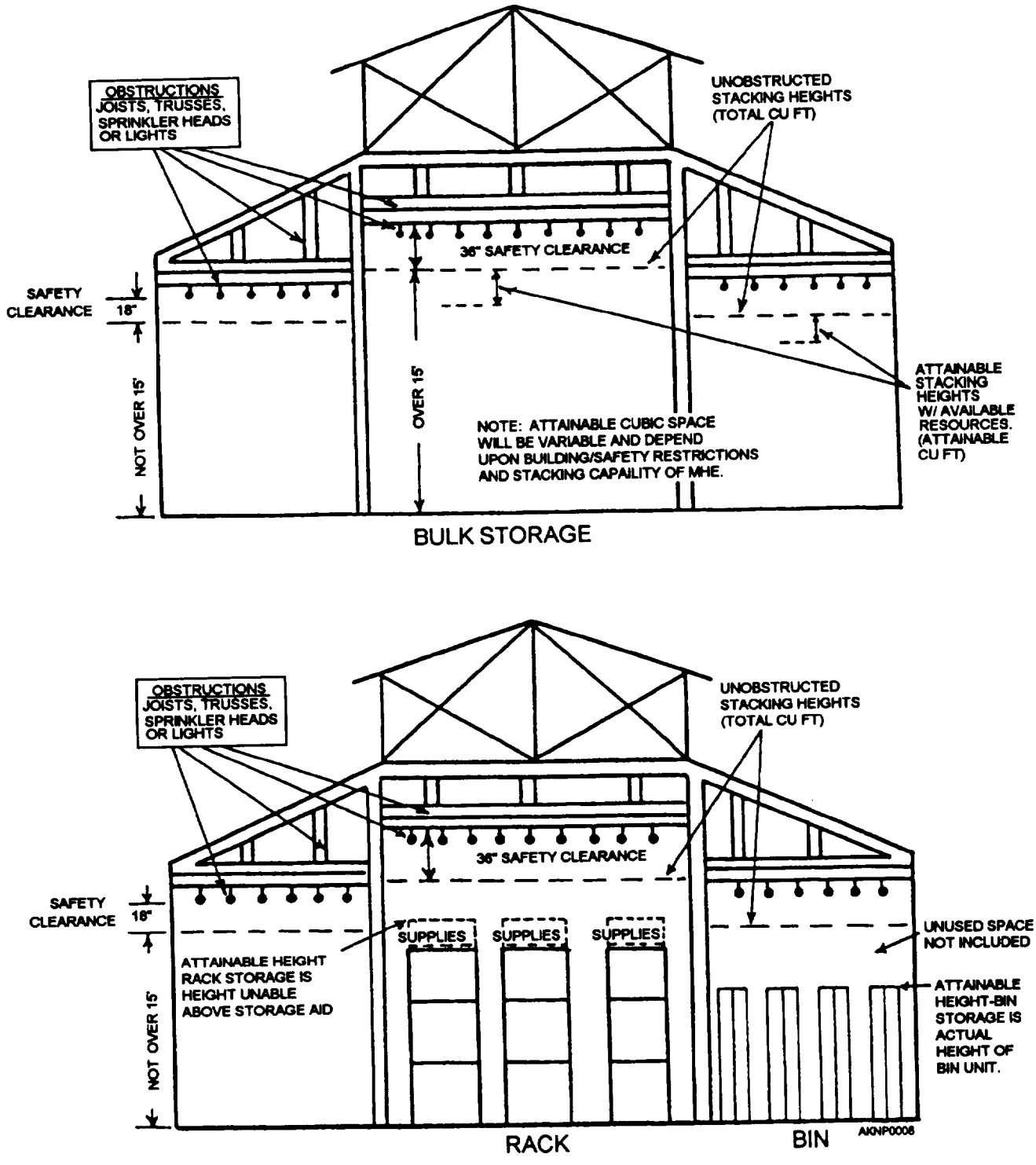

Figure 2-8.-Example of determining cubic space capicity.

For own improved storage, compute the total cubic capacity by multiplying the net storage space (SQ FT) by an average stacking height of 10 feet. Remember that stacking height may vary depending on the characteristics of the material.

For unimproved open storage, multiply the square feet occupied by the representative stacking height.

ATTAINABLE CUBIC FEET

The attainable cubic feet is the product of net storage space (SQ FT) multiplied by the stacking height permitted by safety regulations and floor load limitations with the use of MHE. Therefore, the attainable cubic feet represents the cubic space usable or available for storage with existing resources as shown in figure 2-8.

For determining the attainable cubic feet for improved open storage, use the same formula as cubic space capacity.

BIN CUBIC CAPACITY

The cubic capacity of the bin is computed by multiplying the length by the width by the height of its outside dimensions. The unused cubic space above the bin will not be included as attainable space.

RACK CUBIC CAPACITY

The cubic capacity of the rack is computed by multiplying the outside dimensions of the length by the width by the height. The cubic space above the rack is included to the extent permissible by safety regulations.

OCCUPIED SQUARE FEET

The occupied square feet is the area occupied by bins, racks, and materials in covered or open bulk areas. The bin and rack space is considered occupied whether or not material is stored therein. To determine the occupied area (SQ FT), multiply the length by the width.

OCCUPIED CUBIC FEET

Determine the occupied cubic feet by multiplying the net square feet by actual storage height(s).

Compute the bin and rack occupancy by determining the vacant cubic feet portion and subtract it from the attainable cubic feet.

OCCUPIED NET STORAGE SPACE

The simpler method of determining the occupied net storage space is by computing the total vacant space and subtracting it from the total net storage space. Computing the actual vacant space is easier than measuring the space actually occupied. To compute the vacant space, measure the floor area that is not actually occupied by material. Include the space occupied by empty pallets and dunnage as vacant space.

POTENTIAL VACANT SPACE

The two types of potential vacant space are type A and type B. Type A is short spaces or broken spaces in front of stacks that cannot be used for storing supplies other than identical sires, lots, and so forth. Type A vacant space is usually the result of honeycombing or poor warehousing. Type B is low stacking that is caused by failing to stack material to the full permissible height. The following factors are not considered as potential vacant space: low stacking caused by floor load limitations, the height of roof rafters and ceiling joists, and commodity characteristics.

STORAGE OPERATIONS

The basic storage operations involve receiving, storing, and shipping of materials. An effective supply system greatly depends on the smooth flow of material and paperwork from these operations.

RECEIVING

Quick and accurate processing of receipts directly contributes to an effective supply system. Receiving operations are directly influenced by several factors. These include the type of materials to be handled, distance to storage locations, type of MHE available, and characteristics of the storage facility. The principles of receiving is basically the same. The incoming material is received, processed, and distributed. Some incoming material requires special handling and control. These include materials that are classified as pilferable or sensitive (including small arms). Refer to *Afloat Supply* Procedures, NAVSUP P-485, *Supply Ashore,* NAVSUP Publication 1, Volume 2, and *Department of the Navy Information and Personnel Security Program Regulation*, OPNAVINST

5510.1, for the proper handling of these materials. Hazardous material handling and stowage procedures ashore are provided in NAVSUP Pub 573.

Planning the Receiving Operation

Receipt operation ashore is more extensive than afloat because of the large quantities and more variety of materials being received. Planning and Coordinating the tasks among the players responsible for different phases of operation will facilitate receipt processing. Using advance information before actually receiving the material can make sure that necessary steps are already taken to process them. For example, you can use the advance shipment notice of a classified item to ensure a qualified person is available to receive it. This will enhance quick processing of material receipts. Other documents that you can use for planning purposes are

- purchase orders,
- contract schedules,
- propositioned material receipt documents, and
- advanced shipping documents.

The documents mentioned can give you the arrival dates, category of material, and quantity of each item category. This information should be provided to personnel concerned with scheduling, storing, transportation, packing, preservation, shipping, and document processing. Storage personnel can use the information to determine the location for the incoming material. The dispatcher, on the other hand, can use the information to ensure qualified operators are available for the required MHE.

Planning and coordinating promote effective storage space utilization, efficient assignment of manpower and MHE, and recognition of items requiring special handling.

During deployment, ships receive most stores by underway replenishment (UNREP). While in port, the bulk of material is delivered at pierside from the supporting fleet and industrial supply center (FISC).

Senior AKs play an important role in an UNREP evolution. You must work closely with other senior petty officers and officers of the supply department. You will be involved in planning the replenishment procedures and in supervising the work in progress. Your experience and knowledge are essential in planning the UNREP evolution.

You should consider several factors in formulating local plans for efficient functions of the UNREP under local conditions. These factors include the cooperation of various departments, the stations to be manned, the amount of stores anticipated, the personnel and equipment required, and the special procedures and safety precautions normally employed during replenishment operations.

When all necessary factors are considered and all essential planning, teamwork, speed, and precision have been executed skillfully, the UNREP operation can then be termed successful.

It is important to remember that the ship is in a vulnerable condition during an UNREP evolution. Failure to take proper safety precautions because of incomplete planning or confused execution could result in a great loss of life and prevent the ship from performing its primary mission.

Unloading Operations

Unloading operations require planning and on-site supervision. Personnel performing this function must be familiar with the procedures for inspection and verification of material receipts. The mechanics of unloading supplies vary according to the type of carrier, type and weight of material, type of unloading facility, and required MHE.

Personnel safety is important when unloading supplies. Before unloading a sealed truck, check the condition and number of the seal. If the seal is broken or missing, annotate the discrepancy on the documentation. In case of sensitive cargo, notify the transportation office and security before unloading. Conduct a preliminary inspection when the truck door is opened. If there is evidence of damage or shortages, suspend the unloading operation, if practical, pending inspection by the carrier's representative.

Unloading supplies at a receiving dock platform requires abridge plate and dock leveler to permit entry of MHE to the truck. Unloading at ground level requires the use of a portable platform or ramp to allow entry of the forklift truck.

Materials that need to be transported to the storage area either directly from the carrier or receiving area should be palletized. Maximum palletization facilitates rapid and efficient unloading operations. Position containers on the pallet in a way that the markings are visible from the outer rows of the pallet load.

A forklift truck with 2,000- or 4,000-pound capacity and collapsed mast height of 83 inches or less can be used for unloading trucks or containers. Before using the forklift, ensure that the floor strength can support the forklift and load. Also ensure that jacks are in place to prevent the truck from upending.

Checking Incoming Material

Basic receiving actions include checking the number of containers and inspecting for apparent damage. Material should be tallied concurrently with the unloading operation. If the quantity received matches the shipping document, circle the quantity. Annotate a discrepancy on the receipt document by recording the actual count and circling the adjusted quantity. Refer to NAVSUP P-485 and NAVSUP Publication 1, Volume 2, for detailed procedures on receipt inspection and verification.

Receipt Documents

Maintaining control of receipt documents is one of the basic functions of receiving operations. Controls can be made by using receipt logs, suspense files, advance notice listings, and so forth. The flow of receipt documents may vary from other activities. However, receipt processing is not complete until the receipt is posted to the appropriate record and filed.

TRANSPORTING MATERIAL TO STORAGE

Before moving materials to storage, ensure they are properly identified and marked, At a minimum, material should be marked with the stock number, nomenclature, quantity, and unit of issue. These markings are required for material identification. Local procedures may require additional markings such as the receipt document number or location number. Aviation depot level repairable may require other markings such as the family group code or pool number. Properly marked material will ensure accurate accounting, issues, and easier inventory actions.

Moving material to storage is a continuation of receiving, unloading, and receipt processing. Move material by the quickest and moat economical means available. Material movement is affected by the type of material, required MHE, and the distance to the storage area. Some of the equipment that can be used to move the material are conveyors, tractor trailers, pallet jacks, or by hand carts. A forklift truck is generally used to transport material a short distance (less than 400 feet each way).

SHIPPING

This text describes the shipping procedures as they pertain to storage operations. These procedures are primarily involved with selecting the item, processing the issue, and moving the material to transportation for shipment. Refer to *Military Standard Transportation and Movement Procedures* (MILSTAMP), DOD 4500.32-R, for specific shipping instructions.

Planning the Shipment

The effectiveness of shipping procedures depends upon the accuracy of receipt records, proper storage, and proper marking. Planning the shipping operations should start when the material is received for storage. Proper storage operation procedures should simplify stock selection and expedite preparation for shipment. Upon receipt of issue documents or material release authorization, make plans to move the material. Before moving the material for shipment, you should consider the following factors:

- Quantity, weight, and cube of material to be shipped.
- Requirements for security, packing, shipment marking, destination, manpower, and MHE.
- Mode of transportation to be used.
- Date required for release to transportation for further shipment to consignee.

Documentation

In most cases, storage personnel will receive and use issue documents to select and move material in stock. Copies of this document accompanies the material for shipment. Shipments must be properly documented to prevent delay, misdirected shipment, or loss of material. Hazardous material transportation requires special manifests, which can only be prepared by personnel trained to prepare hazardous material for shipping.

Shipment Preparation

Material being shipped must be properly packed, documented, marked, inspected, and assembled in the designated area. In shore activities, materials for shipment are assembled in an area designated for

loading by carriers (transportation service). Afloat, an area may be designated to assemble material that will be off-loaded from the ship and subsequent transfer to the first or final destination. (See NAVSUP Publication 573 for documentation information of hazardous materials.)

INVENTORY

Maintaining accurate records of quantity, condition, and ownership of material greatly helps in achieving maximum economy in management and use of supplies. Verification of these records is accomplished through physical inventory. Basically, physical inventory is the actual count of an item in its storage site. In the supply system, physical inventory includes other functions as listed in the following text:

- verification of stock record balances,
- conducting investigations,
- analyzing inventory discrepancy,
- adjustment of stock records, and
- adjustment of financial records.

The inventory of items that are classified, sensitive, and pilferable is called *controlled item inventory*. Information concerning the physical inventory program in the Navy is described in NAVSUPINST 4440.115.

Planning the Inventory

When planning the inventory, consider the following factors:

- number of items involved,
- number of locations,
- manpower required,
- anticipated productivity,
- scheduling to obtain maximum efficiency and accuracy, and
- preparation of material in storage to facilitate counting.

You can use these factors to outline different steps needed to accomplish the inventory.

Assignment of Inventory Personnel

Each person participating in the inventory must be given a specific assignment. To facilitate teamwork, conduct necessary training for all personnel involved before performing the inventory.

Preparation of Material for Inventory

Proper storage practices can make performing an inventory easy. Before starting the inventory process, storage personnel must prepare the materials for inventory. Storage personnel must ensure that materials are

- properly identified and clearly marked,
- stored in a minimum number of locations,
- uniformly stored by quantity per container, package, or pallet,
- marked “DO NOT INVENT0RY” if excluded in inventory count.

SECURITY OF MATERIAL IN STORAGE

As a general procedure, material in storage must be kept under lock and key when practicable. The requirements for maintaining security of material are described in NAVSUP P-485 and NAVSUP Publicat.ion 1, Volume 2. Protecting material in storage and preventing internal pilferage are two of the functions of a storage operation. Preventing loss of material can save dollars and time.

If not properly secured, material losses in such proportions could jeopardize the mission of the command. Loss of critical supplies for tactical use could result in the unnecessary loss of life and danger to national defense.

Control Measures

Specific measures for preventing pilferage may vary in different activities. The most practical and effective method used for controlling pilferage is the establishment of physical security and psychological deterrents. These can be accomplished in a number of ways as described in the following:

- An aggressive security program is an effective means of convincing personnel that they have much more to lose than they do to gain by engaging in theft.
- The supervisor must set the proper example and maintain a desirable moral climate for all storage personnel.
- Let storage personnel know that it is their responsibility to report any loss to proper authority.
- Institute adequate inventory and control for accounting material in storage.
- Establish and monitor lock and key control procedures.
- Perform an investigation about suspected losses quickly and efficiently.
- Establish a material control system to include inspection of delivery and vendor vehicles.
- Establish accurate methods of taking physical inventories and accounting of material procurement, usage, and salvage,

Security of Items Requiring Special Handling

Classified items should be kept separate from other material. The most satisfactory method is to store these items in a separate building with a higher degree of physical protection. Where a separate building is not available, a room, cage, or crib may be constructed within a storage building. Spaces containing classified material must be secured by means of an approved locking system.

Pilferable and sensitive items should be stored in a secured area to prevent theft. The storage area could be a vault, cage, or fenced and locked security space. Normally these items will not be stored with classified material. However, when instances require these items to be stored with classified material, the storage area will be classified. In this case, the control applied to these items is equivalent to the highest security classification of any item in storage.

In some cases, pilferable items may require storage in general-purpose spaces. For example, items were received in large banded containers for which secure storage space is not available. In this case, storage in a general-purpose space is permitted. However, when containers are opened to make issues, the residual quantities should be transferred to the specified secured area.

MATERIAL HANDLING EQUIPMENT

Material handling is the process of moving material to, from, and through one production area to the other. The method used for moving material may vary but the basic principles are the same. The following information lists some of the guidelines in moving material.

- Keep handling of material to a minimum. Minimum handling saves money and manhours and reduces wear and tear of materials and equipment.
- Use standardized methods and equipment. Standardization of equipment results in the reduction of costs of operation, in maintenance, repair, storage, and simplified issue procedures.
- Select an MHE that can perform a multiple number of applications. Consider flexibility when selecting the type of equipment to be used.
- Minimize the use of specialized equipment. Material handling operations requiring special equipment are costly. The operating and maintenance cost of special equipment is higher than the cost for standard equipment.
- Minimize the length and number of moves of materials. Study the movement paths for possibilities of reducing “backtracking” and length of moves to facilitate better use of MHE and personnel.
- The rated capacity of an MHE must not be exceeded. Overloading causes excessive wear of equipment and creates additional accident potential.
- Greater payloads for each handling operation result in less handling cost per piece.
- The straight line flow of travel is the shortest distance between production areas.
- Preposition materials for MHE operations. This means placing the material in the area that will facilitate pickup and adhere to safety procedures. For conveyor operations, place materials in such

a manner as to reduce accidents and lessen equipment damage.

- When practicable, move material in a horizontal plane or with the aid of gravity. The ideal lifting point of material is at the waist level. The nearer to the waist the material can be picked up or disposed of, the greater the efficiency.

Material Handling Equipment Requirements

A balanced operation provides for the optimum number of people and MHE to complete a specified workload. Too many personnel and not enough MHE (or vice versa) can cause bottlenecks. To produce a smooth operation, you should know how to determine the MHE requirements for the job.

You should consider several factors when selecting the MHE requirements. If all supplies to be moved are palletized and squared off for stacking, you may need a forklift truck and operator. However, you might need personnel to manually handle some materials. Terrain, location arrangement, design of the building, and extent of the open storage area will also affect MHE requirements. Material characteristics will also affect selection of the required MHE. Some material may require the use of electric or battery-operated forklift trucks.

COMPUTING MHE REQUIREMENTS.– TIhe following factors should be used in computing MHE requirements.

- The volume or size of the operation to be performed (for example, the number of pallet loads to be moved to another area is 48 pallets).
- The number of units of the volume carried in each trip (for example, the number of pallets carried by the forklift truck in each trip is two pallets).
- The average time expended to accomplish a round trip (for example, one round trip takes 5 minutes to finish).
- The allotted time to finish the job (for example, the job should take 2 hours to finish).

The formula for determining the MHE requirement is as follows:

FORMULA: $\frac{V}{C} \times T + AT = R$

Explanation of symbols;

V — Volume or size of the operation to be performed

C — Units of volume carried per trip by MHE

T — Average expended time to complete around trip

AT — Allotted time to do the job

R — Equipment requirement

Using the data in the examples above, the computation will be as follows:

$\frac{48}{2}$ x 5 + 120 (rein)= 1 forklift truck

NOTE: We use the requirement for forklift trucks in the example assuming the distance of travel is less than 400 feet).

COMPUTING PALLET REQUIREMENTS.— The measurements of a standard pallet is 40 x 48 inches. Allowing for overhang (roughly 25 percent), the square feet occupied by each pallet is approximately 16(4 ft x 4 ft). If procedures permit stacking of four pallets high, four pallets are required for each 16 square feet of net usable storage space. The formula for determining pallet requirements is as follows:

FORMULA: $\frac{S \times H}{D} = R$ **(Pallet requirements)**

Explanation of symbols:

S— Net covered storage area, (in SQ FT) used for bulk storage.

H—Average stacking height expressed in pallet course (pallet loads).

D—Square feet of floor area occupied by pallet size with 25 percent added to compensate for load overhang and clearance.

R—Quantity of pallets required.

For an example, compute the pallet requirements for 59,500 feet of usable floor spare with stacking height of four pallets. The computation is as follows:

$\frac{59,500}{16} \times 4 = 14,875$ **pallets**

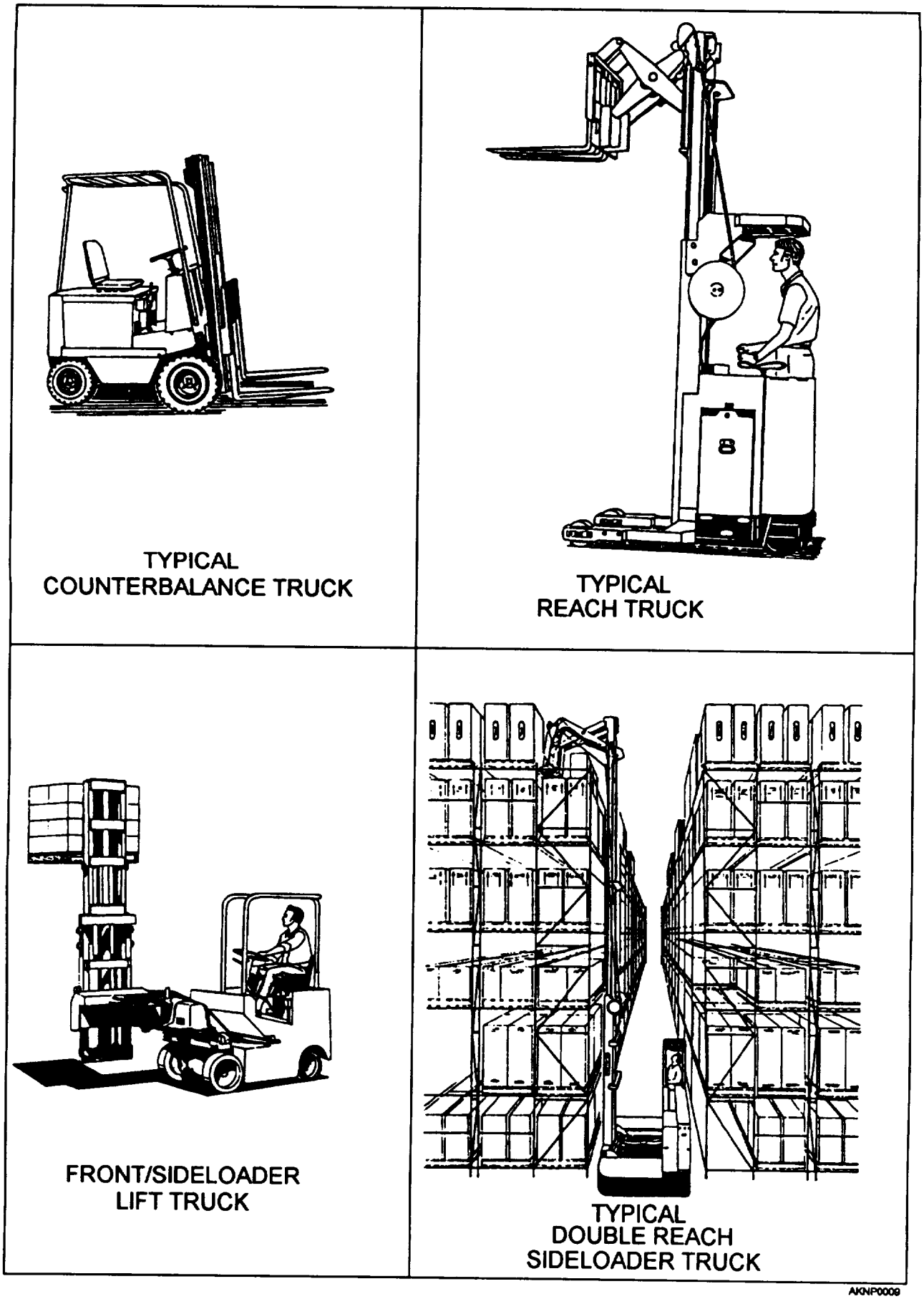

Figure 2-9.-Forklift trucks.

Forklift Trucks

Forklift trucks (fig. 2-9) are vehicles designed to pick up and carry unit loads of materials. The types of forklift trucks commonly used by the AKs are discussed in the following paragraphs.

COUNTERBALANCED TRUCKS.— TMS type of truck (fig. 2-9) carries the pallet load straight in front on permanently aligned forks. These trucks must turn at right angles to place the material in storage. They require wide aisles and substantial floor capacity. They are available in electric or internal combustion models.

NARROW-AISLE TRUCKS.— These trucks are in three categories; the straddle, reach, and side-loading truck (figure 2-9). In straddle trucks, the load is carried between the front outrigger wheels to minimize the need for counterbalancing. Straddle forklift trucks are also known as tiering trucks. The reach truck is a variation of straddle or tiering truck. It is commonly used in shore activities. It is more maneuverable than the standard forklift trucks and can generally operate in narrow aisles.

Side-loading trucks normally operate to one side of the aisle and place the load laterally. These trucks come in various designs. Some travel along the length of the aisles with permanently located masts, equipped with a reach device to move the forks out from the side. Some types have moving masts that add to the extension capability and permit double placement of the load. Other types have a rotating or swing mast that can reach out to the side. These types of trucks are also known as *front/side loaders.*

Dollies

A dolly is a small, low platform load carrier that is generally equipped with rollers, casters, or wheels. Dollies are hand propelled (do not have handles) and are used for low-volume moves over short distances.

Hand Trucks

The types of hand trucks are the two-wheel and four- or six- wheel platform.

TWO-WHEEL HAND TRUCKS.— Two-wheel hand trucks are designed for tilt and carry operation. They are generally used for moving small volume and lightweight items over variable paths and limited space.

HANDLIFT TRUCK, MK 45.— This is a special type of hand truck that is used for lifting and maneuvering long heavy containers. They are used in pairs with one truck positioned at each end of the container. The AKs may use this type of truck for moving some types of aircraft engine containers such as an F404 engine container. This truck consists of an aluminum body, a tow bar, and a lift mechanism It is equipped with two wheels and polyurethane tires. The lift mechanism includes a lift arm and a mounting pin for engaging the load. The lift mechanism is manually operated by a reversible ratchet wrench to raise or lower the lift arm assembly. (See figure 2-10 for an illustration of handlift truck, Mk 45.) When used on board ship, this equipment is usually under the inventory responsibility of the weapons department.

FOUR-WHEEL HAND TRUCKS.— The four-wheel hand trucks are rectangular load-carrying platforms fitted with a handle at one or both ends. Some types are equipped with two swivel casters located at the comers of the platform. Other models have two large wheels centered on the sides and two smaller wheels centered on the ends. The four-wheel hand trucks are used for moving low volume and light loads for short distances.

OPERATORS OF MATERIAL HANDLING EQUIPMENT (MHE)

This chapter provides only the basic information needed to supervise and guide the MHE operators. Consult your local and higher echelon directives and procedures concerning licensing and safety requirements. In this chapter, the MHE refers to a forklift truck.

To qualify as an MHE operator, each person is required-to meet some specific requirements. These include the vision, hearing, and reaction tests.

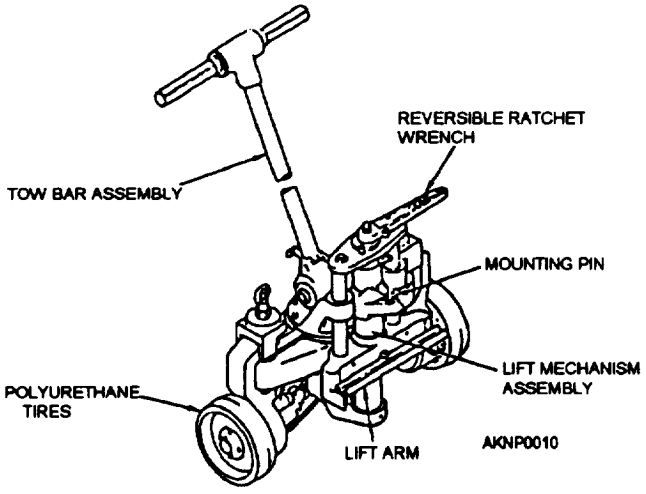

Figure 2-10.—Handlift truck, Mk 45.

Individuals in the Navy should have already passed these tests. Completing a training program for familiarization, safety, and operation is also required before receiving an operator's permit.

Forklift Safety

The following safety rules are applicable to forklift truck operations:

- Forklift truck operators must slow down at cross aisles and passageways.
- When entering or leaving a building, the operator must come to a complete stop at the entrance, sound the horn, and proceed only when the way is clear.
- Under all conditions, the forklift truck must be operated at a speed that will permit it to be brought to a stop in a safe manner.
- When traveling, the forks must be raised not more than 4 inches above the deck. When parked, the forks must be lowered to rest on the deck.
- Forklift trucks must not be used to bump or push the stacks to straighten them out.
- The maximum load capacity of the forklift truck must not be exceeded.
- Drive the forklift truck forward when transporting a load up ramps and backward when transporting a load down ramps. The mast of the forklift truck must be tilted backward when transporting a load.
- Use a safety pallet when lifting of personnel is authorized.
- Personnel are not allowed to ride on the forks.
- When parking, the operator must ensure parking brakes are set and the forklift truck will not move.
- The operators must not cut corners when traveling. This practice may result in upset loads, damaged goods, or injury to personnel.
- When using a bridge plate, it must be secured in position to prevent slipping, and strong enough to support the weight of the forklift truck and load.
- Operators must not attempt to repair forklift trucks. The supervisor must be notified to get a qualified person to repair the vehicle.
- Forklift trucks must be equipped with overhead guards, and operators must wear hard hats.

Fundamental Operational Instructions

The trainee should learn the different controls, preventive maintenance, warehousing procedures, stacking methods, and safety rules pertaining to forklift trucks. Before using the MHE, the trainee should be instructed to check the following:

- Fuel
- Water or coolant
- Oil level
- Tires (pressure and excessive wear)
- Fire extinguisher (if installed)
- Forks (to ensure they are secured)

After mounting the forklift truck, have the trainee check the following:

- Horn
- Brakes (both parking and foot)
- Position of gear shift lever (should be in neutral)

After successfully completing the fundamental operating instructions, the instructor should demonstrate the proper operation of the MHE. The instructor should show the trainee how to drive the MHE to go forward and backward. The trainee should be cautioned against driving with the foot resting on the clutch pedal. "Riding the clutch" results in loss of tension in the clutch springs, allowing the clutch to slip, thereby causing excessive wear. The instructor must explain to the trainee that the forks should be raised high enough for safe clearance, yet low enough to permit a clear view ahead when traveling with or without a load. If the load obstructs the operator's forward view, the operator should drive the MHE in reverse.

After completing the instructions above, the trainee may be allowed to practice driving. The trainee should drive the MHE forward and backward. Next, let the trainee drive in circles and figure eights using reduced speed.

After completing the basic maneuvers, the instructor may let the trainee drive through an obstacle

course (if required by the command). The next step of training is load handling. Instruct the trainee to approach a pallet, insert the forks into the pallet as far as they will go, lift, and move the pallet. The trainee should lift the pallet, tilt the mast back, and move forward or backward. In unloading, instruct the trainee to lower the pallet to the deck and tilt the mast to a vertical position so that the forks can be removed easily.

After successfully completing the required training, the trainee may be issued a permit to operate the MHE.

SUMMARY

The Aviation Storekeeper supervisor must be able to plan and coordinate to create efficient supply operations. This chapter will help you do this. The terms and definitions we discussed will help you in supervising the storage or warehouse. We also discussed the methods and procedures for planning the storage and office layout to provide a safe and smooth flow of operations.

The objectives in storing material is to conserve space, move rapidly, assure stability, and have a form of orderliness. We discussed the stacking height and arrangement of stacks to conserve storage space. We can assure speed in material movement by applying the storage techniques described in this chapter. We also discussed the different types and required number of MHE needed for moving materials by unit loads to save time and resources. We covered the stability of material in stems by using storage aids, such as pallets and racks, and the orderliness of material in storage that facilitates movement and inventory functions. We discussed the factors that help promote orderliness in the storage area; these include the stowage aids, required access, material identification, and the location system used.

We discussed the methods and terms used in computing the measurements of storage spaces and the required number of MHE and pallets. This information should help you in overall storage space management and control and preparation of required reports.